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(71) Applicant
Oki Electric Industry Co Ltd (Japan),
7–12 Toranoman 1-chome, Minato-ku, Tokyo, Japan

(72) Inventor
Hiroshi Etoh

(74) Agent and/or Address for Service
Stevens Hewlett & Perkins,
5 Quality Court, Chancery Lane, London WC2A 1HZ

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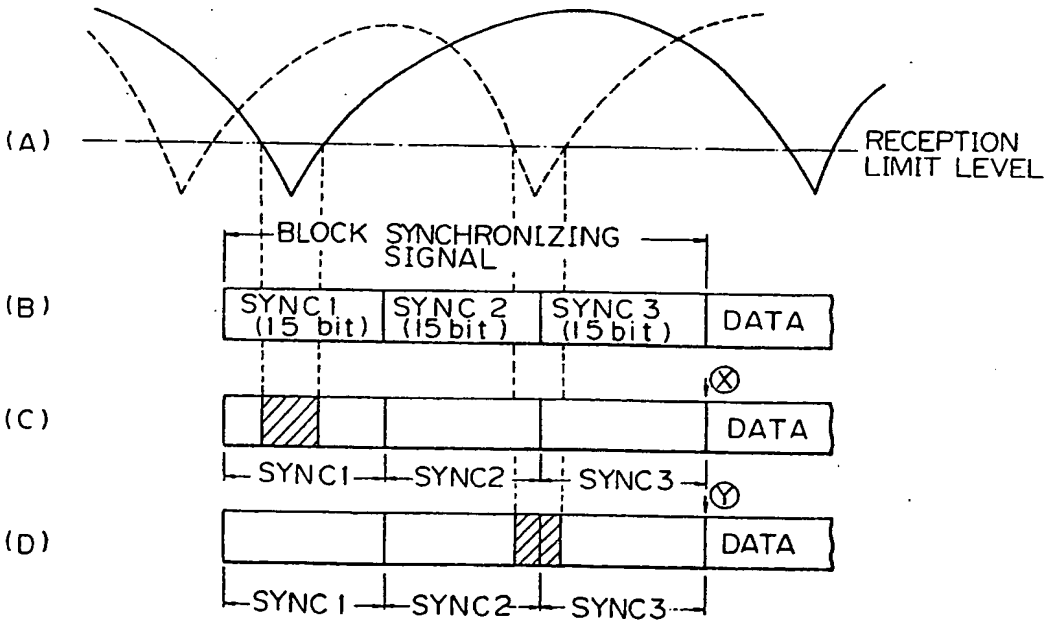
Selected US specifications from IPC sub-class H04L

(54) Synchronisation of start of data signals

(57) A block synchronisation data communication system enables data communication to be properly effected even through a transmission channel exhibiting extremely unfavourable conditions, such as in mobile radio, in particular automobiles. The block synchronisation data communicating method comprises the steps of encoding data to be transmitted and forming the encoded data into blocks, adding a block synchronisation signal having a plurality of different successive pattern SYNC1, SYNC2 and SYNC3 positioned in a prescribed order at the head of each data block, transmitting the data block together with the block synchronising signal, receiving said transmitted data and recognising one of said patterns constituting the block synchronising signal, estimating the data position based on the position within the block synchronisation signal of the properly recognised pattern, and decoding the data block beginning from said estimated position as received data.

Fig. 3



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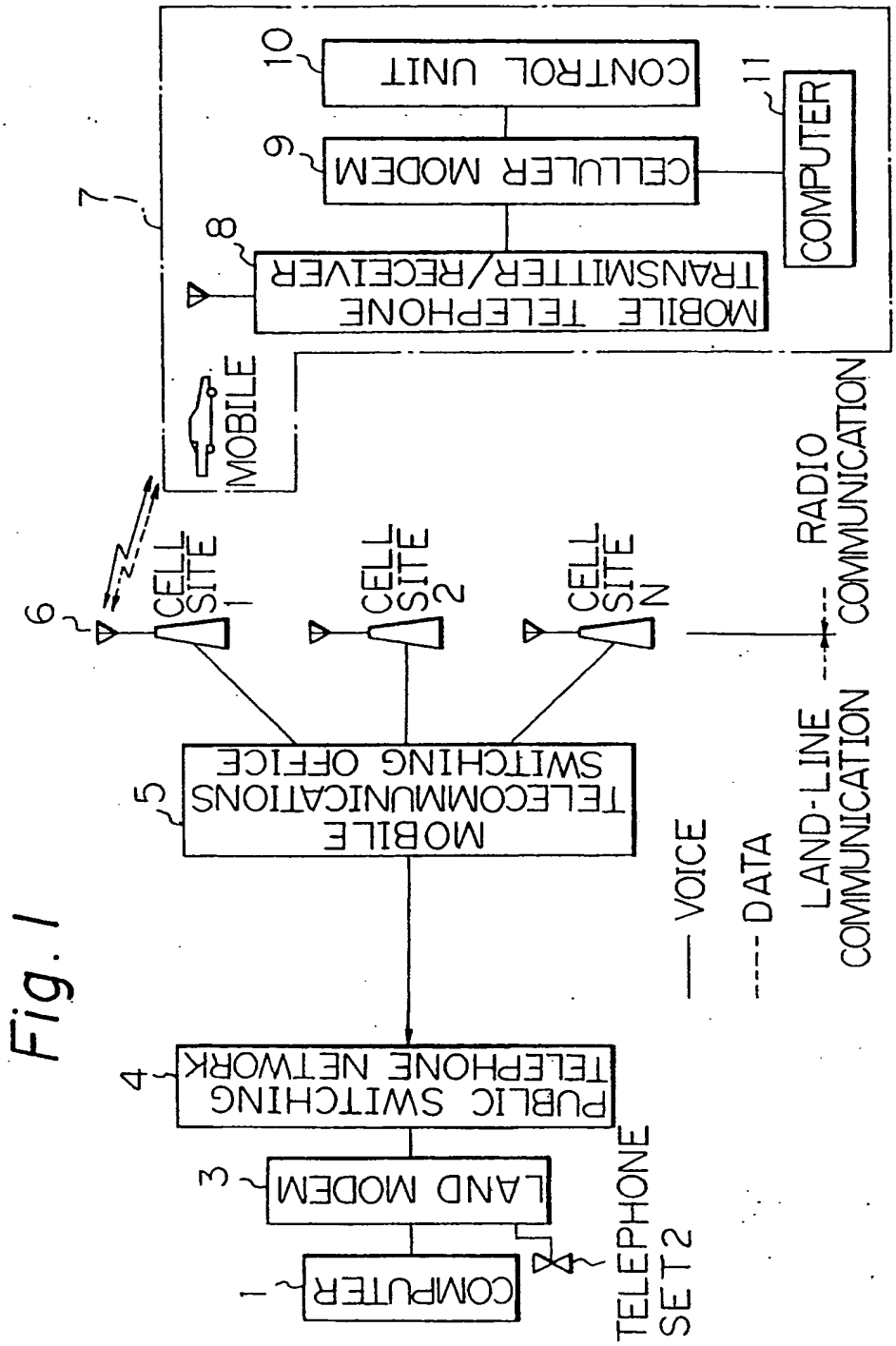

Fig. 1

Fig.2

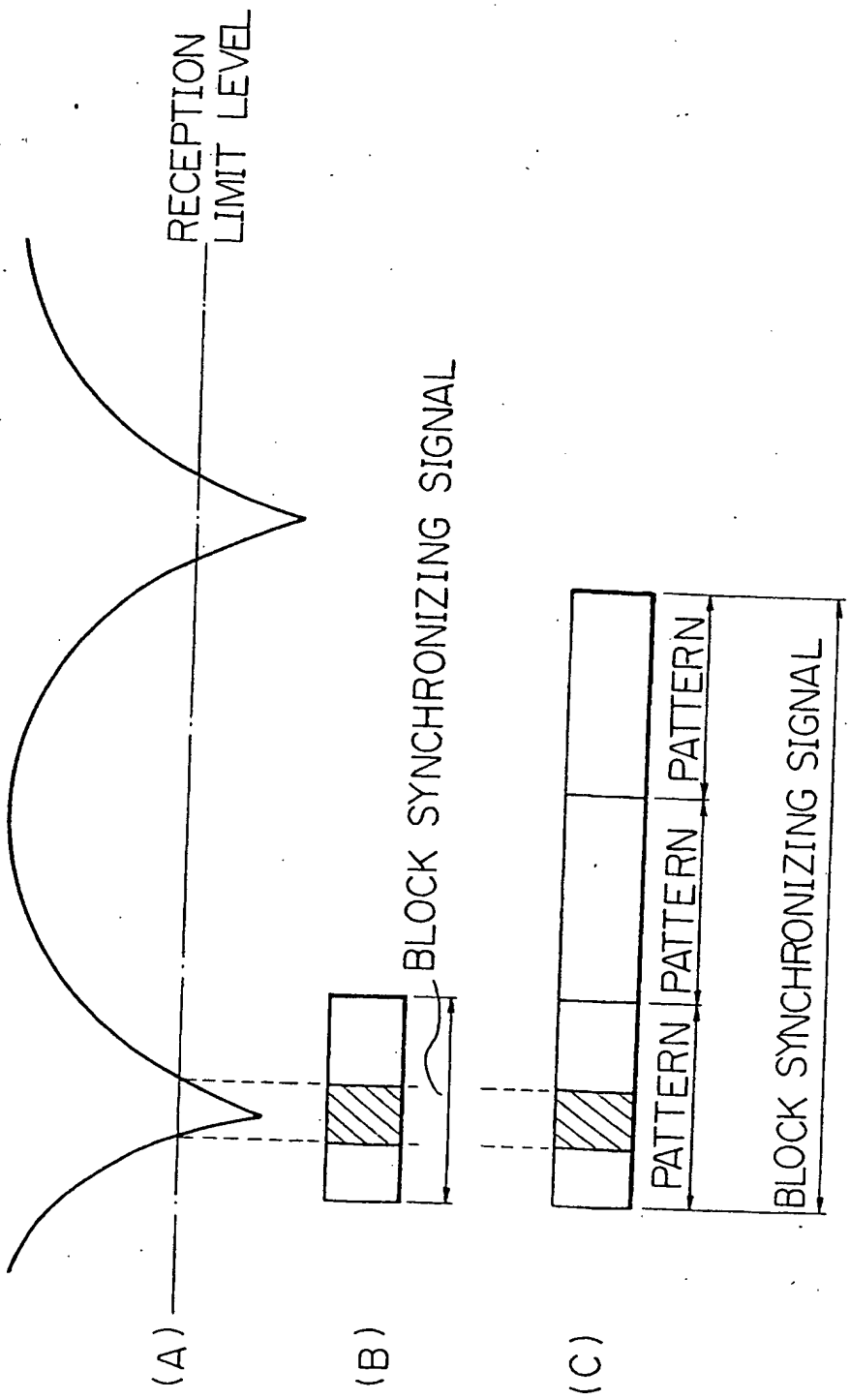
RECEPTION
LIMIT LEVEL
BLOCK SYNCHRONIZING SIGNAL
PATTERN
PATTERN
PATTERN
BLOCK SYNCHRONIZING SIGNAL
(A)
(B)
(C)

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Fig. 3

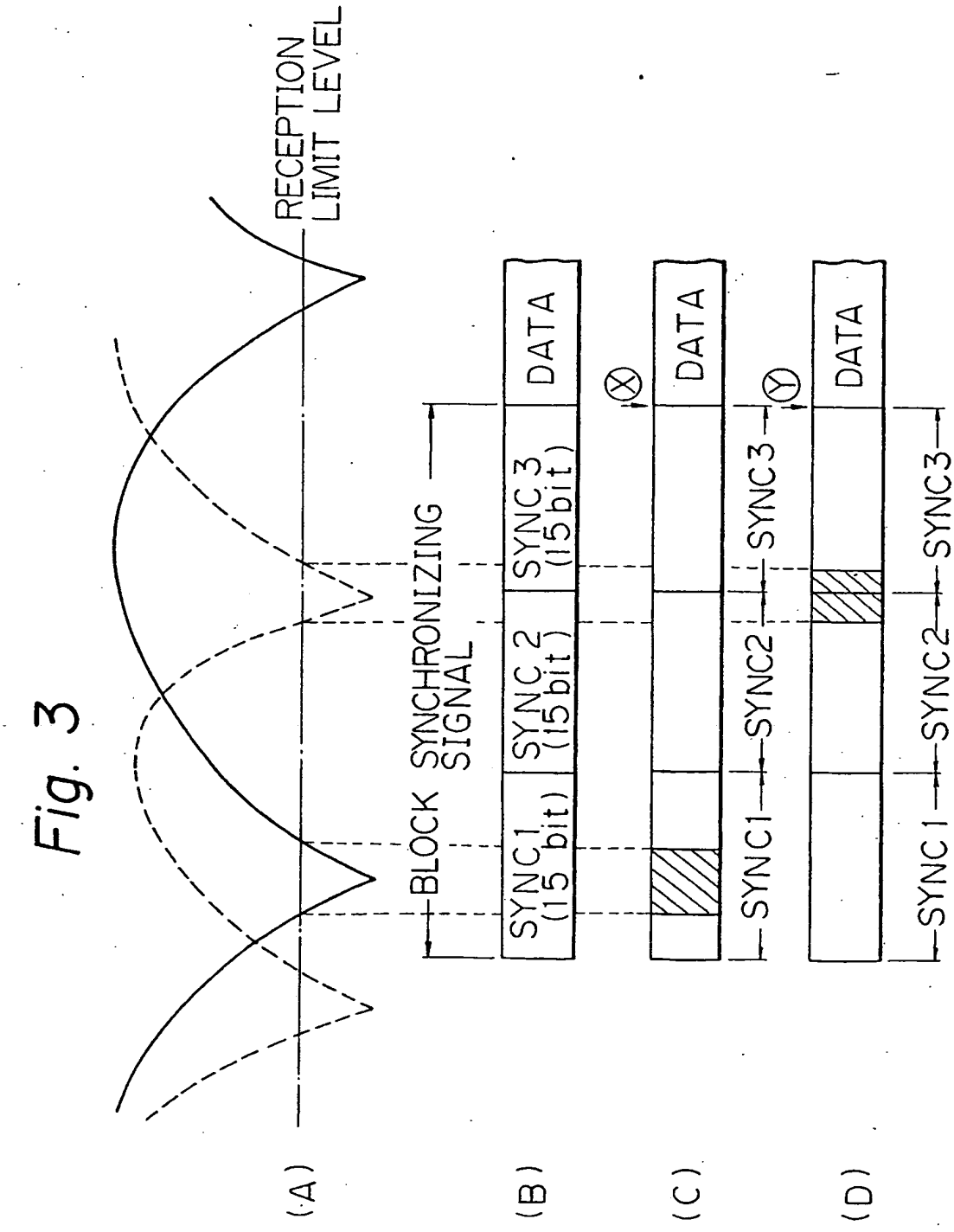

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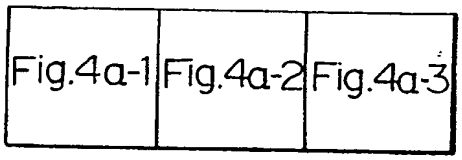
Fig. 4a

Fig. 4a-1



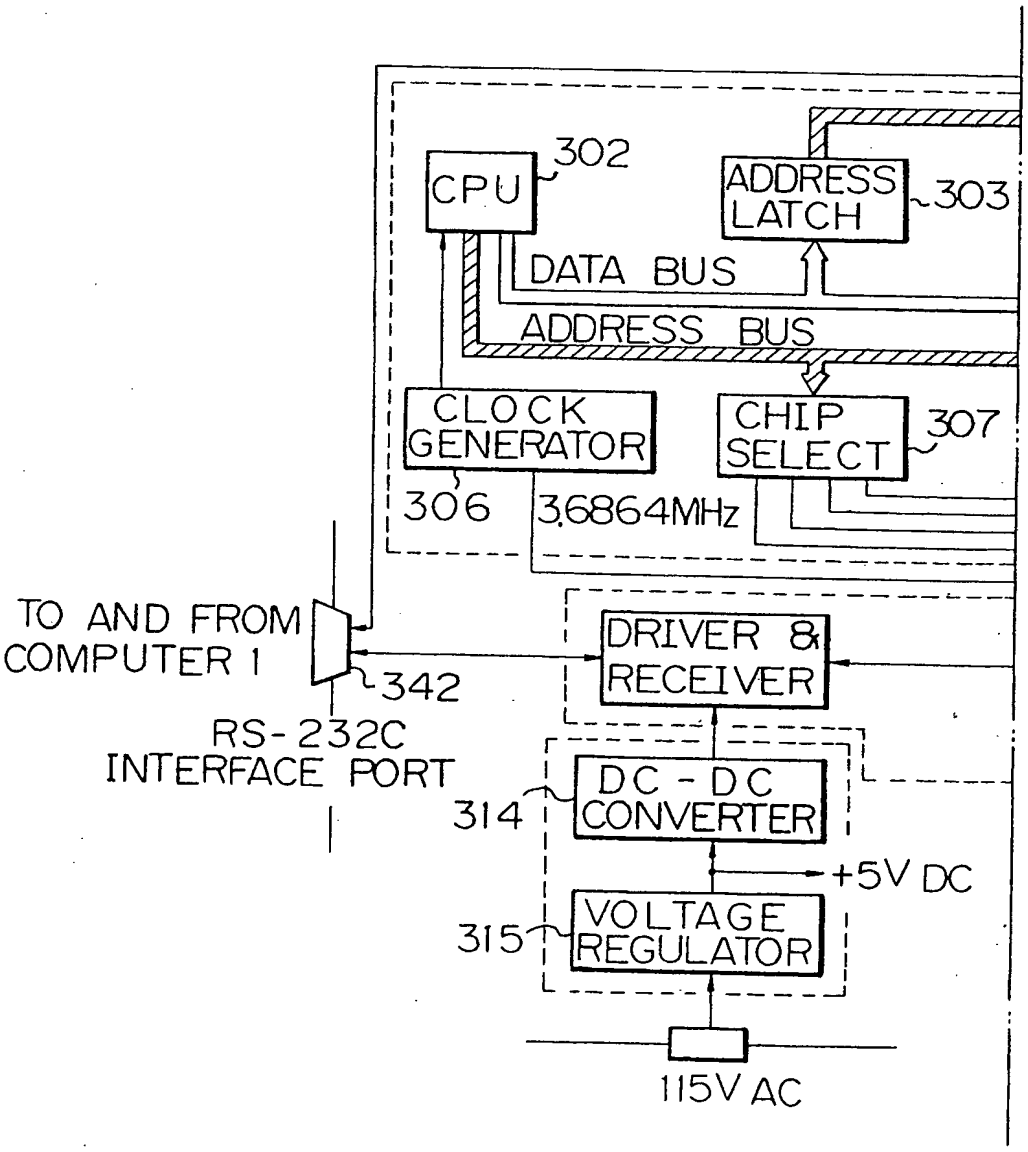


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Fig. 4a-2

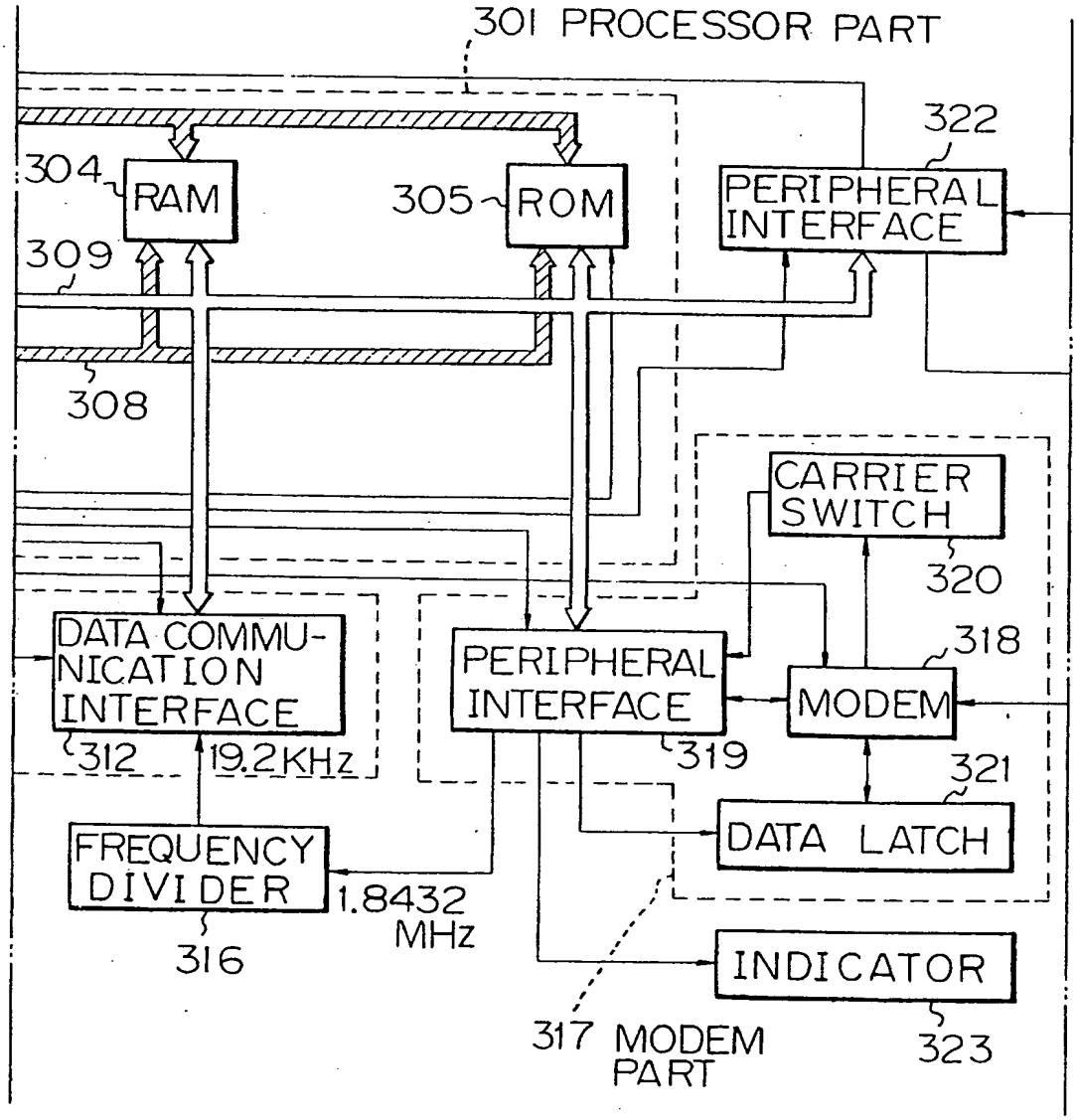

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Fig. 4a-3

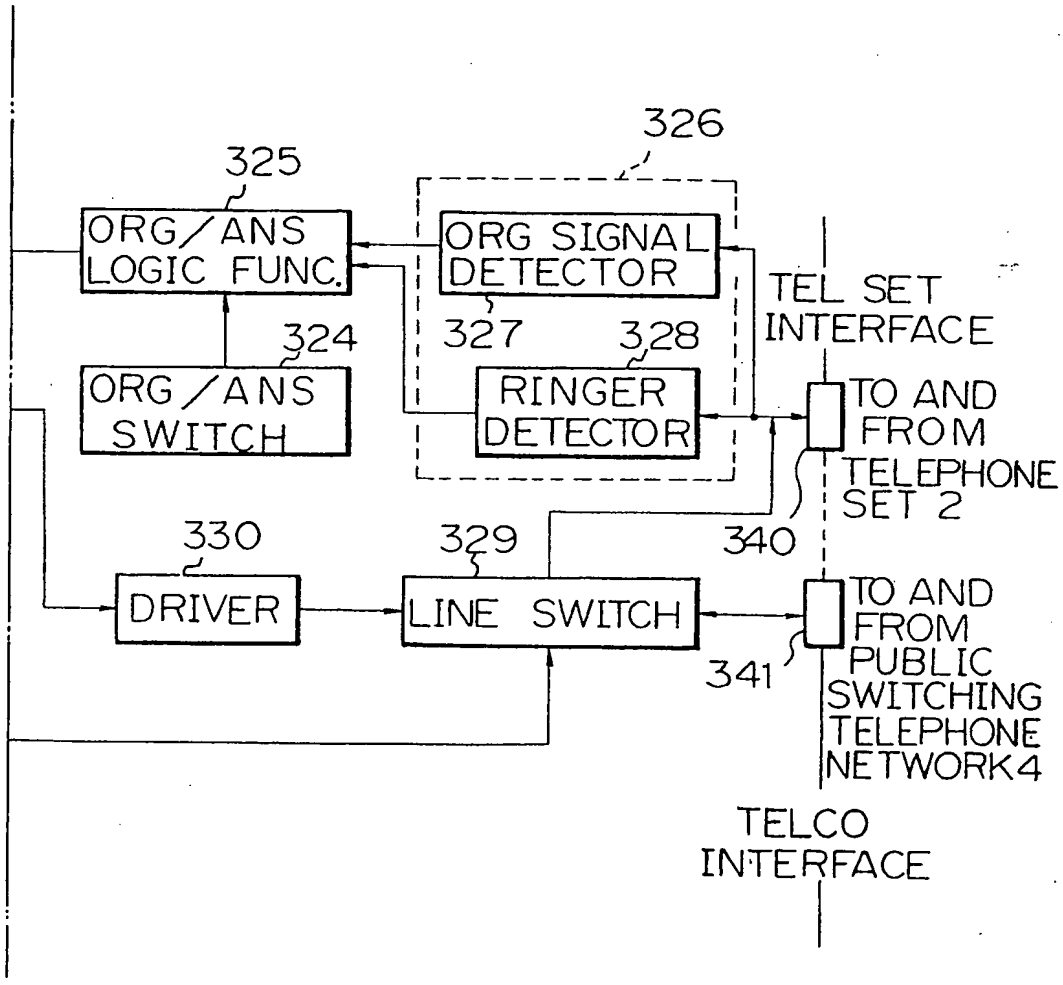
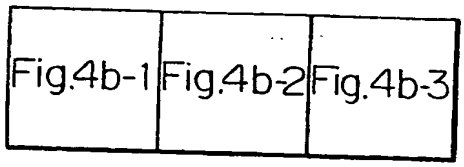


Fig. 4 b

Fig. 4 b-1



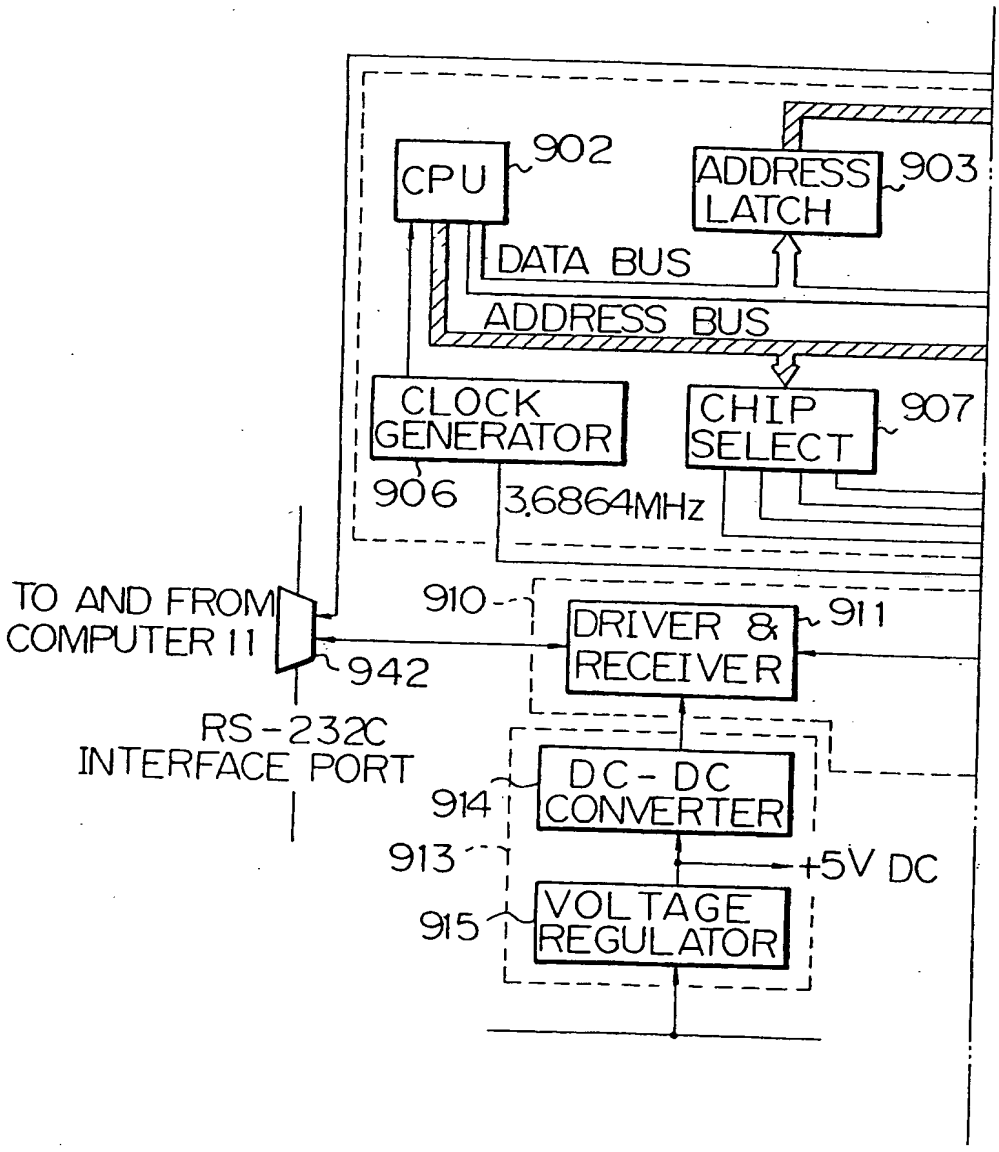


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Fig. 4b-2

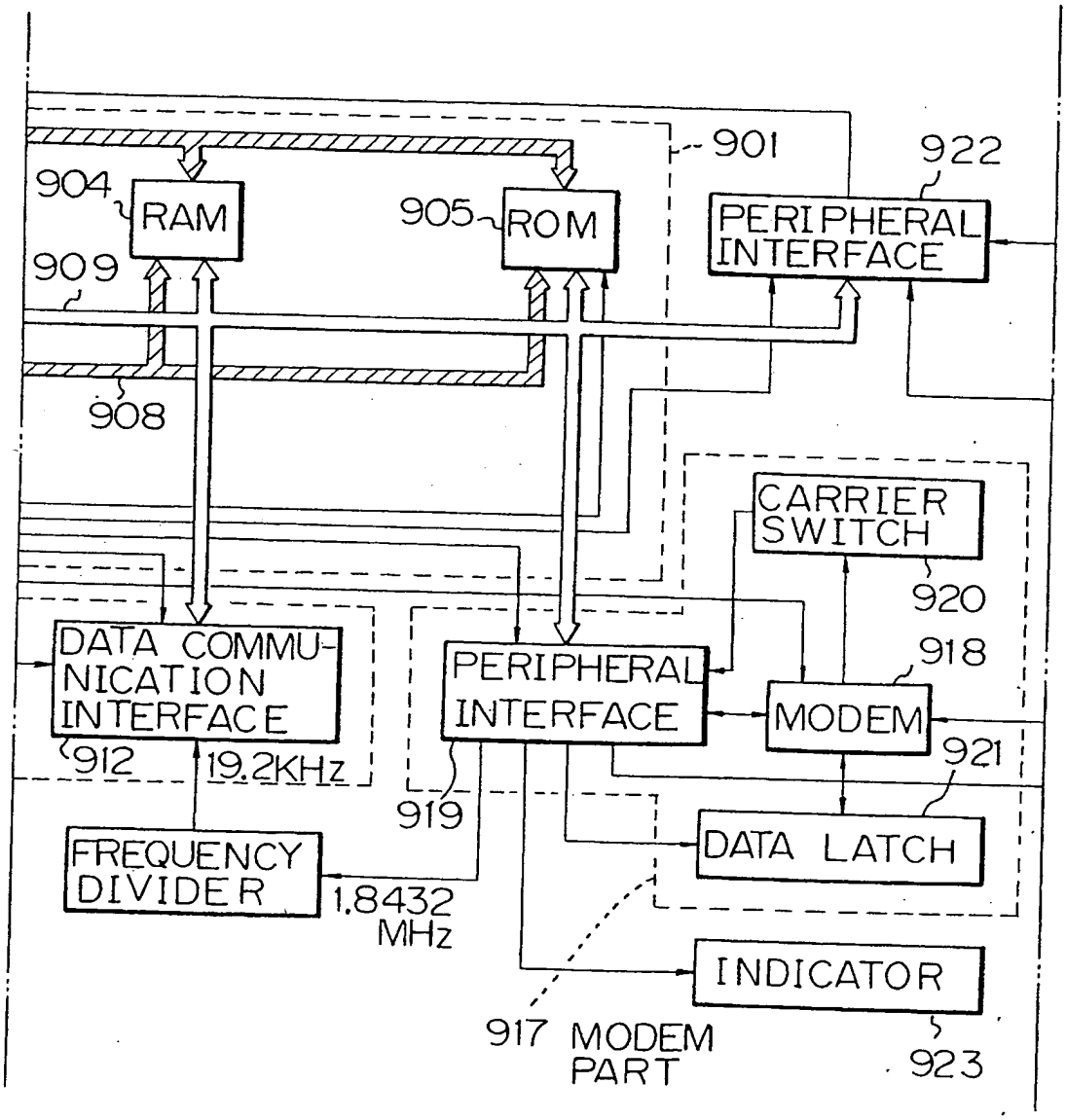

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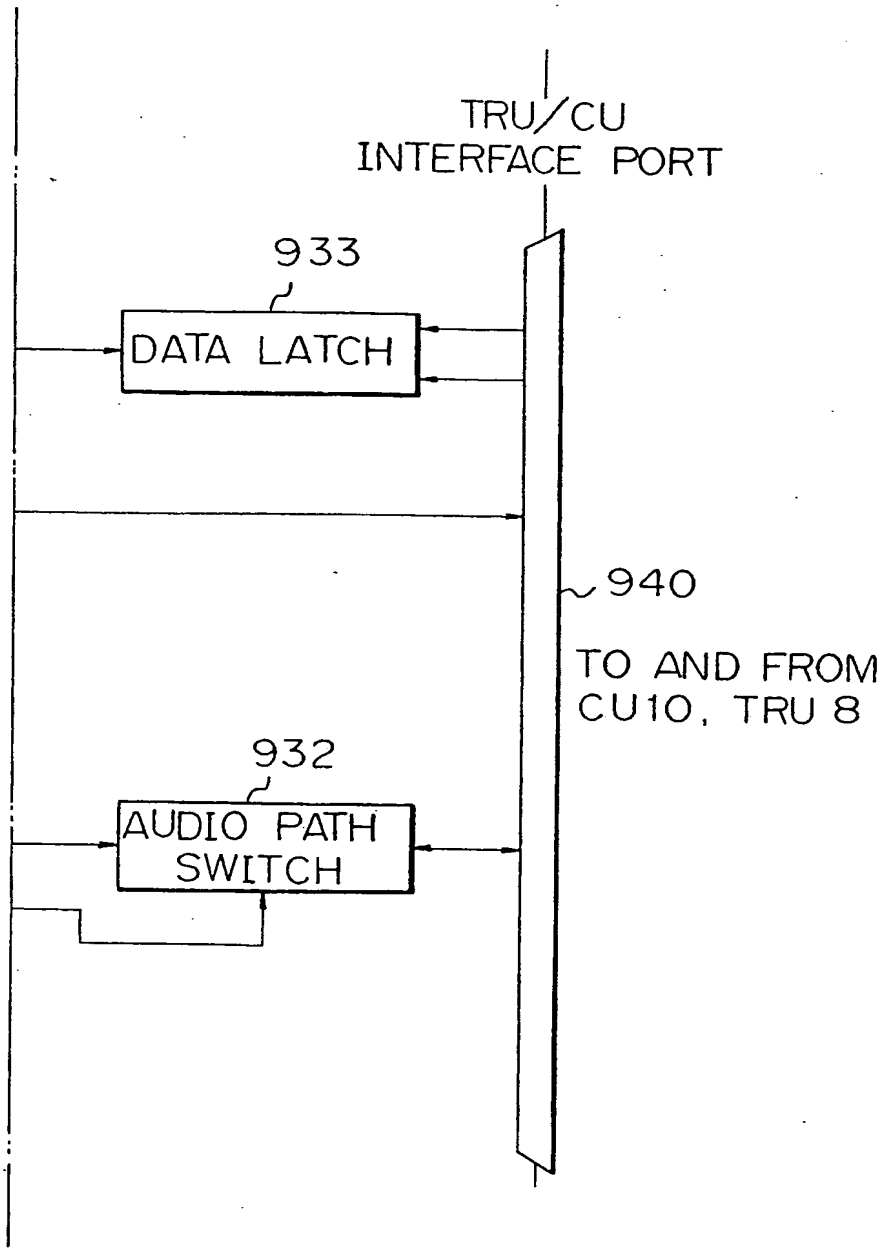
Fig. 4b-3



SPECIFICATION

Method of block synchronisation of data in a mobile radio communication system

The present invention relates to a method of block synchronisation of data in a mobile radio communication system such as that in automobiles.

Mobile phone systems are now commercially available in Japan, Canada, USA and various countries in Europe, and data communication with mobile radio has, at long last, begun to be put to a practical use. Mobile radio data communication is communicated through a transmission channel under severe handicaps, such as fading. Thus, such data communication may suffer from errors. To solve this problem, the data in question is commonly subjected to error correction encoding and is blocked for transmission. A communication system utilising such error correction is called a block synchronisation transmission system in which the blocks of data are each synchronised with one another by a block synchronisation signal. Many methods have been proposed up to now for such systems. An example is described in "Computer—Data communication Techniques" - The Elements In Data Communication -, written by E. Macnamara, translation by Hiroyuki Watanabe from CQ Publishing Co., Ltd., PP 138 to 141, wherein two methods are given. One of these methods utilises a block synchronisation signal with a single pattern having an arbitrary bit length and employs it one at a time for transmission. The other repetitively transmits the pattern three or more times and identifies it as being a proper block synchronisation signal provided that it is received two times or more in succession. In addition, another technique is given in "Advanced Mobile Phone Service: Control Architecture" by Z.C. Fluhr et al, THE BELL SYSTEM TECHNICAL JOURNAL, JANUARY 1979, which describes a data format in data communication (P58, Figs. 8 and 9). However, only with a single pattern, it is not recognized as a block synchronisation if it is received by mistake. Likewise, with a single pattern transmitted a plurality of times, it cannot easily be ascertained from which portion a data fraction begins in the signal if the pattern is received by mistake.

The present invention seeks to provide a method for effecting block synchronisation data communication capable of transmitting and receiving block data in a proper synchronised relation via an extremely badcondition transmission channel as might be found in mobile radio such as that in automobiles.

A block synchronisation data communication method in mobile radio according to the present invention comprises the steps of:

(1) a step of encoding data to be transmitted and blocking it,

(2) a step of adding to the head of the blocked data a block synchronisation signal having a plurality of different patterns successively arranged in the prescribed order.

(3) a step of transmitting the blocked data added with the block synchronisation signal,

(4) a step of receiving the transmitted data and recognising one of the patterns constituting the synchronising signal,

(5) a step of estimating the data position based on the constitution position of the pattern properly recognised in the block synchronisation signal, and

(6) a step of decoding the blocked data beginning from the estimated position as received data.

In order that the invention may be better understood, an embodiment thereof will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a schematic view illustrating a data communication system for use in mobile radio;

Figure 2 is a view illustrating a prior block synchronisation system;

Figure 3 is a view illustrating an embodiment of the block synchronisation system according to the present invention;

Figure 4 is a block diagram of a data modem on the land side with use of the block synchronisation system according to the present invention; and

Figure 4b is a block diagram of a mobile cellular modem with use of the system according to the present invention.

In Figure 1, illustrating a mobile radio data communication system, designated at 1 is a computer, 2 is a telephone set, 3 is a land modem, 4 is a public switching telephone network 5 is a mobile telecommunications switching office (MTSO), 6 is a cell site, 7 is a mobile, 8 is a mobile telephone transmitter/receiver unit (TRU), 9 is a cellular modem, 10 is a control unit (CU), and 11 is a computer. The above members from the computer 1 to the cell site 6 are located on the land side, while those from the TRU8 to the computer 11 are carried on the mobile 7.

Referring to Figure 1, data communication between the computer 1 on the land side and the computer 11 carried on the mobile 7 will be described. Although the computer 1 and the telephone set 2 are connected with the land modem 3, the computer 1 is connected with the land modem 3 by switching the system to a data mode. Data from the computer 1 is supplied in a block unit to the land modem 3 in which it is subjected to error correction encoding, and then fed to the public switching telephone network 4. The data is further allowed to pass, via the MTSO 5 and the cell site 6, through a radio communication channel, and received by the mobile phone transmitter/receiver unit (TRU)8 of the mobile

7. The received data is subjected to decoding, etc., by the cellular modem 9 which then delivers the data to the computer 11 provided the data is decided to be normal. If it is decided that the received data is erroneous, then the mobile side requests the land side to transmit the same block of data again. Effecting the above procedure repeatedly results in data blocks being transferred from the computer 1 on the land side to the cellular modem 9 of the mobile 7. The same procedure is effected also when, in contrast with the above situation, data is transmitted from the computer 11 of the mobile 7 to the computer 1 on the land side. Moreover, communication can also be achieved by phone between the telephone set 2 and the control unit (hand set) 10 of the mobile 7.

It is general in mobile radio data communication systems to employ a block synchronisation signal to transfer block data.

Prior to describing the block synchronisation communication system according to the present invention, a conventional method such, for example, as those described in the literature mentioned before will be described with reference to Figure 2. As shown in Figure 2 showing fading experienced by a signal in mobile radio, a signal higher than a reception limit level can be received without any error, whereas that lower than the level can contain errors. In the case of Figure 2(B) illustrating an example wherein a block synchronising signal comprises a signal pattern, a hatched portion of the signal is not properly recognised as a block synchronisation signal since that portion is erroneously received. On the other hand, another block synchronisation communication system is shown in Figure 2(C) wherein the same pattern is transmitted three times in repetition, and in this case the data is recognised as a proper block synchronisation signal provided that two succeeding patterns can be found. Although the first of the patterns is not properly recognised as a synchronisation signal because of its erroneous reception, the second and third patterns are recognised as a block synchronisation signal because of their proper reception. However, when a block synchronisation signal only comprises a single pattern as shown in Figure 2(B), the signal is not recognised as a block synchronisation signal when it contains errors, while in the multiple pattern case shown in Figure 2(C) it is difficult to decide at what position a sequence of properly recognised block synchronisation signals is located among the three block synchronisation signals.

Against this, with the block synchronisation system according to the present invention, a plurality of different subsequent patterns construct a block synchronisation signal, and a pattern constituting the block synchronisation signal is recognised on the receiving side, and the data position is estimated on the basis of a properly recognised pattern position for block synchronisation.

In Figure 3 illustrating a block synchronisation communication system according to the present invention, solid and dotted curved lines of Figure 3(A) respectively show signal fading and the straight line on the horizontal axis represents a reception limit level. A block synchronisation signal for use in the present embodiment is shown in Figure 3(B), and comprises three successive patterns SYNC1, SYNC2, and SYNC3, each being composed of 15 bits. SYNC1, for example, employs "111101011001000", SYNC2 "000010100110111" and SYNC3 "000100110101111". The receiving side supervises the three patterns SYNC1, SYNC2, and SYNC3. The receiving side recognises any pattern thereamong in order to detect the position of the pattern in the block synchronisation signal, and estimates the first position of the data in question.

Let us, for example, consider a case wherein a block synchronisation signal shown in Figure 3(B) is received as shown in Figure 3(C) via a channel having a fading pattern shown by the solid line in Figure 3(A). It is assumed that the pattern of SYNC1 includes a portion less than the reception limit level and is erroneously received, while the other patterns SYNC2 and SYNC3 are received properly. In this instance, it is decided that the data in question begins on and after the 16th bit (i.e. from the position of X on) since the pattern of SYNC2 previously properly recognised is properly recognised (there is thus no problem even if SYNC3 is erroneous).

Let us now consider a case wherein the block synchronisation signal shown in Figure 3(B) is received as shown in Figure 3(D) via a channel having a fading pattern as shown by the dotted line in Figure 3(A). The patterns of SYNC2 and SYNC3 include a portion less than the reception limit level and are erroneously received while the pattern of SYNC1 is properly received. Accordingly, in this case, it is decided that the data in question begins on and after the 31st bit (from the position of Y on) since SYNC1 was recognised.

The block synchronisation transmission system according to the present invention is employed in both devices of the data modem 3 on the land side and the cellular modem 9 of the mobile 7, as shown in Figure 1. Block diagrams of the land modem 3 and the cellular modem 9 are respectively shown in Figures 4a and 4b, wherein designated at 301 is a processor, 310 is a RS232C interface, 313 is a power supply and 317 a modem. A computer 1 is connected with a RS-232C interface port 342, a telephone set 2 connected with a TELSET interface 340, and a public switching telephone network 4 connected with a TELCO interface 341, as shown in the same figure.

Operation of data transmission from the land

modem 3 on the land side to the mobile 7 will be described below.

First, a switch 324 is operated whereby whether the mode in question is transmission or reception is detected in an ORG/ANS Logic Func, part 325. The present case is set to transmission. The transmission mode is supplied to a CPU302 of the processor 301 via a peripheral interface 322, whereby the CPU302 is informed of the start of the transmission. Then, the CPU302 interrogates the RS-232C interface 310 about whether the computer 1 connected the RS-232C interface 310 is ready or not. Then, data to be delivered f rom the computer 1 is incorporated in a RAM304 via the processor part 301 and the RS-232C interface 310, and subjected to error correction encoding for preparing block data. In the case of data communication through the telephone, since the land modem 3 is connected to the telephone 2 via the TELSET interface 340, a line switch 329 is, upon initiating the data communication, switched to the TELCO interface 341 whereby the land modem 3 is connected with the public switching telephone network 4. The CPU302 waits an ACK signal (reception ready signal) from the mobile 7 on the receiving side. The ACK signal is entered in the land modem 3 via the TELCO interface 341, demodulated by a modem part 317, and incorporated in the processor 301 via the peripheral interface 319. The modem 317 is a well known type and so operation thereof will not be described here. The CPU 302, upon receiving the ACK signal, starts to transmit the blocked data which has already been stored in the RAM 304. Furthermore, the CPU302, upon transmitting each data block, adds a block synchronisation signal to the head thereof. The block synchronisation signal comprises three patterns SYNC1, SYNC2, and SYNC3 each pattern being composed of 15 bits, as shown in Figure 3(B). The data block, together with its block synchronisation signal, is delivered to the public switching telephone network 4 via the RAM 304, a peripheral interface 319, a modem 318, the line switch 329, and the TELCO interface 341, and transmitted to the mobile 7 via the MTSO5 and the cell site 6. Successive data blocks from the computer 1 are likewise subjected to error correction encoding and are added to a respective block synchronisation signal in the RAM 304 for transmission.

Operation of the mobile 7 which receives the transmitted data will be described with reference to Figures 1 and 4b. The transmitted data is received by the mobile phone transmitter receiver unit 8 of the mobile 7 and transferred to the cellular modem 9. As shown in Figure 4b, designated at 901 is a processor part, 910 is a RS-232C interface, 913 is a power supply and 917 is a modem. The computer 11 of Figure 1 is connected with a RS-232C interface port 942, and the mobile phone transmitter/receiver unit (TRU) 8 and the control unit (CU) 10 are connected with a TRU/CU interface port 940. The data received by the mobile phone transmitter/receiver unit (TRU) 8 is supplied to the modem 917 via the TRU/CU interface port and an audio path switch 932. The modem 917 demodulates the received modulated data and delivers it to the RAM 904 of the processor 901 via a peripheral interface 919. Here, the audio path switch 932 serves to switch a path for an audio signal between the data mode and the conversation mode. The CPU 902 decodes the data sent to the RAM 904. In succession, for the received data, it is checked whether the data is a block synchronisation signal or not. It is investigated at what position any of same patterns as those three kinds of the block synchronisation signal (SYNC patterns) each pattern comprising 15 bits shown in Figure 3(B) are in the received data. The processor 901 decides, as described in Figure 3(C), based on SYNC 2 pattern being properly recognised, that the data in question begins on and after the l6th bit (shown by x) from the end of that pattern, while the processor 901, if it properly recognises the SYNC 1 pattern as shown in Figure 3(D), decides that the data begins on and after the 31st bit from the end of that pattern (shown by Y in Figure 3(D). The received data is decoded and is, if properly received, delivered to the computer II via the RS-232C interface 910 and the RS-232C interface port 942. Likewise, data blocks transmitted from the computer 1 on the land side are transmitted in succession to the computer II on the mobile. Also in a case where any data is transmitted from the computer II on the mobile side to the computer I on the land side, the same procedure as described above can be effected.

Although in the above embodiments, the block synchronisation signal is composed of three successive patterns SYNC1, SYNC2, and SYNC3, a block synchronisation signal composed of two patterns or four or more patterns may likewise be used.

According to the present invention, as described above, since the block synchronisation signal is constituted by a plurality of patterns then, provided that only one thereamong can be recognised, the block synchronisation signal can be recognised even if the remaining patterns are received incorrectly. In addition, it can be decided from what position the data in question begins.

The present invention can profitably be employed for all data communication where fading in a mobile phone, etc., is a problem.

CLAIMS

1. A method of block synchronisation of data in a mobile radio communication system, said method comprising the steps of: encod-

ing data to be transmitted and forming the encoded data into blocks; adding to the head of said blocked data a block synchronising signal having a plurality of different successive patterns positioned in a prescribed order; transmitting the blocked data together with said block synchronising signal; receiving said transmitted data and recognising one of said patterns constituting the block synchronisation signal; estimating the data start position on the basis of the position of the properly recognised pattern within the block synchronisation signal, and decoding the blocked data beginning from said estimated position as received data.

2. A method according to claim 1, wherein said block synchronisation signal comprises three different patterns, and wherein the blocked data position is estimated from the position of the first properly recognised pattern within the block synchronisation signal on the receiving side.

3. A method of block synchronisation of data in a mobile radio communication system substantially as hereinbefore described with reference to Figures 3 and 4 of the accompanying drawings.

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